

5. Severe Accident Research Program

As a participant in the USNRC Cooperative Severe Accident Research Program, the USNRC will make available to the CSN the results of the severe accident research program which consists of the following program elements:

1. INTEGRATED SEVERE ACCIDENT CODE

- MELCOR code development, assessment, and maintenance
- MELCOR Cooperative Assessment Program (MCAP)

2. DETAILED IN-VESSEL ANALYSIS CODE

- SCDAP/RELAP5 code development, assessment, and maintenance

On request, the USNRC make available to the CSN the above codes developed under this program and provide limited assistance to the CSN in the application of these codes and other related codes which may be available to the USNRC for transfer to the CSN.

Within the above program elements the USNRC will:

- Provide CSN with copies of all pertinent technical program documents such as quick-look reports, technical memoranda and notes, and laboratory reports as soon as they have received appropriate USNRC management review. The USNRC shall also provide the CSN, upon request, copies of all relevant published documents issued before the date of this Agreement;
- On request, make available to the CSN the above codes developed under this program and provide limited assistance to the CSN in the application of these codes and other related codes which may be available to the USNRC for transfer to the CSN.
- Permit personnel sponsored by the CSN to participate in technical review meetings and technical progress meetings except for those meetings primarily concerned with administrative and fiscal matters;
- Facilitate visits by personnel sponsored by the CSN to sites at which work relevant to the objective is being carried out;
- Permit the assignment of personnel sponsored by the CSN to participate and work in the USNRC's severe accident research program and to have full and ready access to relevant documentation, codes and results as described above; and

- Provide the CSN from time to time with more general information relevant to progress in other related areas of its program so that a broader assessment can be made by the CSN or its contractors.

6. Safety of High-Burnup Fuel:

The USNRC will make available to the CSN the results of the nuclear fuels program which consists of the following program elements:

- Argonne National Laboratory (ANL) ring stretch tests under reactivity-initiated accident (RIA) conditions
- ANL oxidation and LOCA criteria test of BWR and PWR cladding
- FRAPCON-3 and FRAPTRAN code development and assessment
- BWR power oscillation calculations
- Brookhaven National Laboratory studies and calculations of RIA accidents in PWRs
- Oak Ridge National Laboratory studies on Burnup Credit and Criticality
- ANL measurements of isotopic content at high burnup
- ANL long-term creep tests for dry storage conditions
- Idaho Nuclear Engineering and Environmental Laboratory dry cask examination results.

The USNRC will provide CSN, upon request, with copies of all the pertinent technical program documents such as quick-look reports, technical memoranda and notes, and laboratory reports as soon as they have received appropriate USNRC management review. The USNRC shall also provide the CSN, upon request, copies of all relevant published documents.

7. Aging Research

The USNRC will provide the CSN pertinent information and results associated with the USNRC aging research program.

The aging research program is an experimental and analytical program designed to upgrade the basis for design, fabrication, operation and inspection criteria, as well as for the analysis procedures required to evaluate performance under normal, upset and accident loadings for systems, structures and components. A primary goal is to improve the definition of failure probabilities and failure modes, and to establish ways by which the failure probabilities can be reduced if this is considered necessary.

The NRC aging research program is exploring a wide range of topics including primary system integrity, seismic issues, structural integrity issues including containment, and studies on selected electrical equipment. A significant factor in the research programs conducted considers plant operation beyond the design lifetime (typically 40 years for long-lived systems, structures, and components, including margins) to address aging issues in terms of their safety importance

and significance. Currently under investigation are aspects of such aging areas as:

- Reactor pressure vessel integrity including the effects of radiation embrittlement;
- Environmentally-assisted cracking and other degradation mechanisms including degradation of reactor internals and recent pipe and control rod drive mechanism (CRDM) nozzle cracking events;
- Environmental qualification of electrical equipment to assure that the equipment has the capability to perform as designed over the life of the plant and can survive during loss-of-coolant type accidents;
- Age-related degradation of containments and other civil structures and passive components to assess their margins of safety for the plant's design lifetime (typically 40 years) and beyond. The response of aged containments and other civil structures and passive components to external events such as earthquakes is a key element of the research).
- Containment performance and integrity program for validation of analytical predictions of capacity reduction for degraded containments to include performing assessment of in service-inspection techniques to investigate degradation of containment shells and liners, and developing a risk-based methodology to judge the acceptability of degraded containment.

Within the above areas of research, specific studies and tests are being conducted to evaluate the safety of nuclear components in the primary system as follows:

Reactor Vessels

- Pressurized Thermal Shock Studies
- Fracture Mechanics Development
- Irradiation Effects and Dosimetry
- Fracture Toughness

Environmentally Assisted Cracking

- Fatigue and Fatigue Crack Growth
- Irradiation Assisted Stress Corrosion Cracking
- Cracking of Ni-alloys

Nondestructive Examinations

- Ultrasonic Testing for Vessels and Piping

Steam Generator Tube Integrity

- Eddy Current Tests for Steam Generator Tubes
- Leak and Burst Predictive Models
- Leak Rate Estimation Models

The USNRC will provide the CSN with research reports (NUREG and contractor reports) pertinent to the projects upon their publication. The information contained in these reports will be subject to Article V of this Implementing Agreement.

8. Site Characterization

The USNRC will provide the CSN, on request, information on its research programs and codes related to site characterization or external events analysis of nuclear power plants and other USNRC licensed nuclear facilities.

9 Radionuclide Transport in the Environment

On request, the USNRC will make available to the CSN information on its radionuclide transport in the environment program, and useful calculation codes related with performance assessment methodology for long term high level waste (HLW) disposal.

This program has as its objective to support NRC decisions on release of contaminated sites, reclamation of uranium mill tailings sites and possibly licensing of future waste disposal sites. Topics under study will include source term characterization, engineered barrier performance, hydrogeologic and geochemical factors controlling flow and transport in soils and fractured rock, and enhancement of overall performance assessment capability.

Projects conducted under this program include:

- Assess alternative techniques for monitoring moisture movement and contaminant transport in the unsaturated zone; test monitoring strategies and instrumentation in the field;
- Assess basic mechanisms controlling radionuclide retardation in soil to enhance predictive modeling of contaminated sites; develop surface completion models for specific radionuclides for use in improving performance assessment calculations.
- Develop a flexible and extensible low level waste (LLW) performance assessment methodology to support decisions on decommissioning and LLW activities including risk assessment, site characterization remediation, and site monitoring.

- Assessment of the long term performance of clay covers, backfills/infills, concrete and grout curtains/slurry walls to contain and/or retard radionuclide migration from decommissioned nuclear sites, uranium tailings sites and LLW facilities.
- Measurement of uranium transport in the environment around uranium ore bodies and abandoned uranium ore piles.

10. Radioactive Waste Management, Storage and Disposal.

The USNRC is currently developing research programs in the areas of storage and transportation of spent nuclear fuel. To the extent possible, the USNRC will, upon request, make available to CSN the published results of the program. Separate cooperative agreements in these areas may also be developed if mutually beneficial to both Parties.

11. Other Considerations

On request, the USNRC will make available to the CSN other related published information on its research activities which may be relevant to the research topics covered in this Implementing Agreement.

Section B. CSN Program Scope:

1. Thermal Hydraulic Research and Code Assessment

This program is being implemented under a separate USNRC-CSN code applications and maintenance program agreement (CAMP) in which the Parties have established the terms and conditions for participation. The USNRC and CSN will continue with the established collaboration in the framework of the program of consolidation of USNRC thermal-hydraulic codes. This collaboration has helped CSN in setting up a Spanish working plan to follow the USNRC consolidation process. CSN will continue providing the USNRC with assessments, developments, results, studies, etc., performed in the context of the national program.

2. Probabilistic Risk Assessment

The CSN will provide the USNRC the results of the application of USNRC Probabilistic Risk Assessment (PRA) analysis methods to Spanish nuclear power plant systems. At the request of the CSN, the USNRC may participate in joint risk analysis projects of interest to the CSN. Such joint projects are to be mutually agreed to and their execution is to be at the expense of the Parties as mutually agreed.

These joint projects may have as objective the use of products developed by the USNRC in its PRA research programs including:

- a) Provide technical support to CSN's staff in the use of SAPHIRE code package;
- b) Development and improvement of PRA techniques to facilitate its use and analysis of Operational Event and Accident Precursor;
- c) Development of Low Power and Shutdown Accident Risk Analysis;
- d) Development of Methods and Decision Criteria for regulatory applications of PRA;
- e) Development of Dependent Failure Methods and Data Analyses Methods;
- f) Development of risk assessments of reactor events initiated by external events;
- g) Applications of PRA insights into Accident Management strategies and capabilities;
- h) Validation of risk analysis for non-reactor nuclear and radiation installations; and validation of methodology for several PRA applications where CSN is gaining experience, e.g., piping in-service inspection, in-service testing, ETF modifications, CSN inspection, CSN internal PRA information system, PRA use in cost benefit analysis.

At the request of the USNRC, the CSN will make available existing risk and reliability analyses of Spanish power plants subject to the information protection provisions of Article V.

3. Accident Management and Human Factors

The CSN will provide the USNRC the results of the application of the USNRC Human Factors Analysis and Accident Management to Spanish nuclear power plants. At the request of the CSN, the USNRC may participate in joint human factors analysis projects of interest to the CSN. Such joint projects are to be mutually agreed to and their execution is to be at the expense of the Parties as mutually agreed. These joint projects may have as objectives the validation and improvement of products developed by the USNRC in the human factors and accident management research plans included in Section A.3 of the Technical Appendix, including:

- a) Development of methods for measuring and evaluating human performance e.g. the problems of Man-Machine Interfaces;
- b) Identify the problems and issues associated with human errors in the operational experience;
- c) Development and management of data bases on human reliability and improvement of integration of human reliability data on PRAs;
- d) Development of methods for measuring the influence of organizational factors by management performance indicators of installations and facilities;
- e) Develop methods for assessment and qualification of personnel performance on man-machine systems; and.
- f) Validation of PRA methodology of human errors of commission

At the request of the USNRC, the CSN will make available to the NRC existing human factors analyses of Spanish power plants subject to the information protection provisions of Article V.

4. Severe Accident Phenomenology and Containment Performance & Integrity Program

The CSN will participate in the USNRC Severe Accident Phenomenology and Containment Performance & Integrity Program and future related programs in this area of nuclear safety research.

Areas of joint collaboration are nuclear safety research in core melt progressions, reactor pressure vessel integrity, fuel-coolant interactions, hydrogen behavior, high burnup fuel behavior, integration codes and applications, fission products behavior and direct containment heating. The CSN will be considered a full partner in this

international program upon making financial contributions in the same proportion as other countries presently participating in this program. As referred on Article VI, in kind contribution could be an alternative formula of payment to the extent mutually agreed.

Another aspect of cooperation is related to Containment Structural Integrity Components in areas of interest such as: validation of analytical predictions of capacity reduction for degraded containments, performing assessment of ISI techniques to estimate degradation of containment shells or liners and developing a risk-based methodology to judge the acceptability of a degraded containment.

Assessments will be done by the CSN or its contractors in applications of severe accident codes received from the USNRC under this Implementing Agreement. The assessments will consist of applications done on experimental facilities which the CSN has access to and/or Spanish nuclear power plants and it is expected that the USNRC or its contractors, to the extent possible, will assist the CSN in the application of these codes.

The CSN will provide the USNRC with comments on general collaboration resulting from CSN Phenomenology and Containment Performance & Integrity Research corresponding to technical areas under the scope of this Implementing Agreement. All CSN contributions described above will be subject to the provisions in Article V of this Implementing Agreement.

5. Aging Research

At the request of the USNRC, the CSN will make available to the USNRC information and reports regarding the results obtained by the CSN in the following areas of its research and development programs:

- Steam Generator Tubes;
- Intergranular Stress Corrosion;
- Fracture Mechanics;
- Aging of Stainless Steel due to Irradiation;
- Nondestructive Testing Technology

The CSN will keep the USNRC informed on the status of the CSN programs in these areas.

6. Site Characterization

At the request of the USNRC, the CSN will provide the USNRC the results of any applications using USNRC codes on Spanish nuclear installations, including nuclear power plants and low- and high-level nuclear waste sites, related to seismic hazards, meteorological and hydrological dispersion and deposition of effluents, temporary storage of spent fuels and other site characterization issues.

The CSN will use the USNRC seismic categorization source code with proper input data and will provide the USNRC the results needed for validation of the code. This task could be considered in kind payment as mutually agreed.

7. Radioactive Waste Management, Storage and Disposal.

On request, the CSN will make available to the USNRC information resulting from use of USNRC codes related to spent fuel interim storage and radioactive waste management, for example, in the area of spent fuel dual purpose casks.

8. Radionuclide Transport in the Environment

The CSN will use available USNRC code packages related to waste disposal performance assessment with proper input data and will provide the USNRC the results needed for validation of the code. This task could be considered in kind payment as mutually agreed.

9. Safety of High-Burnup Fuel

The CSN will provide to the USNRC, upon request, reports describing the following technical work:

1. Results obtained with the FRAPCON-3 code and, in the future, with the FRAPTRAN code in the ongoing studies related to (1) analysis of some of the experiments of the Cabri RepNa Program, (2) expected fuel behavior in the Cabri Water Loop program experiments, and (3) simulation of selected Halden Reactor Program Experiments.
2. Results of the validation work that will be performed by the CSN with fuel depletion codes, based on the Argonne National Laboratory measurements of isotopic content at high burnup that will be provided by the USNRC. The codes to be validated include, but are not limited to, the latest version of the USNRC-sponsored code ORIGEN. The validation results will include those based in other chemical assay data for high burnup fuel, to be in a research program currently being developed.
3. Results of any other validation work performed by CSN with FRAPCON-4, FRAPTRAN and the SCALE system, including their data libraries, based on new experimental data.
4. Results of the ongoing work applying CFD codes to model hot-leg temperature stratification phenomena observed in PWR 3-loop plants.

Separate co-operative agreements in the high-burnup fuel behavior and safety aspects area may also be developed if mutually beneficial to the Parties.

10. Other Considerations

The CSN agrees to cover additional costs as may be required from time to time to *implement CSN designed programs in the above areas of cooperation*. Such costs are to be mutually agreed to in advance and funds are to be secured before the USNRC authorizes the work on behalf of the CSN.